

Prediction of Common Bile Duct Stones by Noninvasive Tests

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Objective

To define accurate and useful predictors of common bile duct stones (CBDS).

Summary Background Data

The ability to predict CBDS with noninvasive tests can avoid unnecessary, costly, or risky procedures.

Methods

All patients referred for examination for CBDS by endoscopic ultrasonography (EUS) from 1993–1996 were prospectively entered in a database. In a first sample selected randomly from the whole population, predictors of CBDS were determined by univariate analysis and logistic regression. Predictors were subsequently tested in that sample and in the rest of the population. A separate analysis was done for patients planned for cholecystectomy.

Results

Eight hundred and eighty patients (328 men, 552 women), aged 57.8 ± 17 years (range 16–94), were included. The

prevalence of CBDS was 18.8%. Age, serum levels of bilirubin, aspartate aminotransferase, alanine aminotransferase, gamma-glutamyl transferase (GGT), and alkaline phosphatase, and the existence of jaundice and fever, a dilated bile duct, and a pathologic gallbladder were found to be associated with CBDS. Logistic regression was undertaken separately for patients younger than 70 years (predictors: GGT $>7 \times$ normal; pathologic gallbladder; dilated bile duct) and older than 70 years (predictors: GGT $>7 \times$ normal; fever $> 38^\circ\text{C}$; dilated bile duct). Odds ratios were 3 to 6.7. The model was satisfactorily applicable to the second sample; age <70 years: $\chi^2 = 3.3$ (NS); age >70 years: $\chi^2 = 3.8$ (NS). In patients younger than age 70 and planned for cholecystectomy, the combination of the level of GGT and dilated bile duct predicted CBDS accurately.

Conclusions

A simple screening of patients at risk for CBDS can be achieved with three predictive criteria adapted for the patient's age.

Gallstone disease is a very common condition involving roughly 15% of the population in Europe and Northern America.¹ In 10% to 15% of cases, cholelithiasis is complicated by the presence of common bile duct stones. Although there is no consensus on this point, many investigators believe that ductal stones should always be removed because of the high risk of complications such as cholangitis or acute pancreatitis.^{2–4} The circumstances in which common duct stones are revealed can be schematized as follows:

1. A patient with symptomatic gallstones who presents for cholecystectomy; preoperative tests or the patient's history suggest current or previous bile duct obstruction.
2. A patient with acute but spontaneously regressive symptoms of bile duct obstruction (abdominal pain, jaundice, fever) and biologic tests suggesting stone migration.
3. A patient presenting as a biliary or pancreatic emergency (acute cholangitis, acute pancreatitis).

Depending on these circumstances, the patient is likely to be managed differently and by different practitioners (surgeons, gastroenterologists, intensive care specialists). However, the important question to be answered in all cases is whether or not a calculous biliary obstruction is still present.

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This will condition subsequent management, including the need for endoscopic sphincterotomy and surgical techniques such as intraoperative cholangiography and open or laparoscopic choledochotomy, which may require specific skills and materials. It is therefore highly desirable to be able to accurately predict the presence or absence of bile duct stones by using cost- and time-saving means, in order to offer patients an optimal combination of currently available therapeutic means. Such a prediction must be based on noninvasive, widespread, and rapidly available tests.

Numerous efforts have been made in the past to define such predictive criteria as well as predictive scores. In a recent meta-analysis, 2221 related articles were identified between 1966 and 1994 just from the English-language literature! However, only 22 met satisfactory methodologic criteria, and no straightforward conclusions were evident.⁵

We decided to undertake a fresh effort on this issue because the development of new diagnostic and therapeutic methods (endoscopic retrograde cholangiopancreatography [ERCP], endoscopic ultrasonography, laparoscopic surgery) has stimulated subjective and empirical attitudes, instead of rationalizing patients' management. Fulfilling our objective required a sufficiently large study population with the broadest variety of referral patterns in order to be representative of the whole spectrum of clinical presentations for choledocholithiasis. This is the case with our study population and prospective collection of data. We also used a "gold standard" diagnostic method for common bile duct stones, endoscopic ultrasonography (EUS), which was applicable to the whole population and had been well validated.⁶⁻⁹

PATIENTS AND METHODS

In 1993, we initiated a comprehensive patient database for biliary and pancreatic endoscopic ultrasonography. This database was designed on the FoxPro software. It included demographic (sex, age), administrative, clinical, biologic, and morphologic data. Every patient referred to the Bachaumont Center for biliopancreatic EUS was prospectively entered into the database. From 1993 to 1996, 1107 patients were entered. From these, 227 were excluded because they were referred for a non-cholelithiasis-related indication; criteria for noninclusion were previous knowledge of a biliopancreatic neoplasia, chronic pancreatitis, or non-cholelithiasis-related biliopancreatic disorders, as well as patients with previous Billroth II gastrectomy in whom common bile duct exploration by EUS is usually not feasible. Eight hundred and eighty patients were finally included. There were 328 men and 552 women, aged 57.8 ± 16.9 years (median 57.5, range 16-94). All 880 patients presented or had previously suffered biliary symptoms. Of those 880 patients, 366 (41.6%) were candidates for cholecystectomy; these were not selected for suspected common bile duct stones, but we were usually asked to perform a preoperative EUS in order to avoid a laparoscopic cholangiography. A

subgroup of 125 patients was composed of patients included in a prospective study at Bachaumont Center in which EUS was systematically performed a few hours prior to laparoscopic cholecystectomy. This subgroup was therefore essentially composed of patients without symptoms at the time of EUS. The other patients were referred for suspected CBDS, with or without the gallbladder *in situ*, in an emergency context (current or recent cholangitis or pancreatitis) in 382 cases (43.4%), or after cholecystectomy in 132 cases (15.0%). In these patients, we were asked to perform EUS, which was immediately followed by ERCP and sphincterotomy if stones were confirmed, during the same anesthesia as EUS.

Patients were referred from private practice surgeons (44.7%), public or university hospital surgeons (18.1%), private practice gastroenterologists (19.1%), medicine departments of public hospitals (13.8%), emergency or intensive care units (3.2%), and general practitioners (1.1%).

The gold standard for the diagnosis of CBDS was EUS.⁶⁻⁹ A positive diagnosis of CBDS at EUS was defined as the presence of a hyperechoic image included in the bile duct lumen, generally in the form of an arcus, with a conic shadowing. The presence of small spots at least 1 mm in diameter, without shadowing, was also considered positive. In 366 cases, the result of EUS was confirmed by ERCP+sphincterotomy and instrumental exploration of the common bile duct performed during the same anesthesia. In 10 cases (2.7%), discrepancies were noted between EUS and ES; six patients were negative for ductal stones on EUS but stones were found at ERCP or sphincterotomy or both, including two calculi impacted in the papilla, one diverticular papilla, and one intrapancreatic cyst masking the common bile duct. In the latter two cases, stones were found located in the upper part of the bile duct, which is inconsistently studied by EUS. Four patients were positive for stones on EUS but negative after sphincterotomy; there was one ampullary carcinoma and one intrapapillary vegetation misinterpreted as distally impacted stones, one diverticular papilla with air trapped in the diverticulum, and one stone which was present during EUS and migrated to the duodenum before sphincterotomy had been performed. In 514 cases, no further nonsurgical exploration of the bile ducts was done.

Endoscopic ultrasonography was performed under general anesthesia (fentanyl + propofol), usually without airway intubation, with a GF-UM20 sector scan unit (Olympus, Tokyo, Japan; two working frequencies of 7 and 12 MHz). When stones were observed, ERCP and sphincterotomy were performed during the same anesthesia by retrieving the echoendoscope and introducing a JF-130 or TJF-130 duodenoscope (Olympus). Sphincterotomy was always followed by Dormia basket and balloon catheter exploration of the bile ducts.

Definition of Bile Duct Stones Predictors

The following elements were studied as potential predictive factors: age, sex, clinical symptoms (pain, fever, jaundice), biologic tests (aspartate aminotransferase [AST], alanine aminotransferase [ALT], gamma-glutamyl transferase [GGT], alkaline phosphatase, bilirubinemia, serum amylase), and morphologic data (from transcutaneous ultrasound or computed tomography scan). Biologic and morphologic data were usually those available in the patient's file as issued by the site of the initial evaluation; these explorations were therefore not reproduced at our center. Biologic tests were expressed as multiples of the upper limit of normal. The spontaneous evolution of biologic tests before EUS was performed, although potentially related to the probability of ductal stones, was not considered because most patients presented with only one set of tests and therefore data were too scarce. However, a spontaneous amendment of symptoms was considered a qualitative criterion as "spontaneously resolving cholangitis." When two sets of biologic tests were available, we always considered the closest to gold standard diagnosis, that is, EUS. The median time span between biologic tests and EUS was 3 days (mean 3.3 ± 2.1 days). Morphologic information with regard to the gallbladder were the presence of a normal gallbladder, a dilated gallbladder, gallbladder stones, gallbladder "microlithiasis" or sludge, or cholecystitis. With regard to common bile duct features, we considered a normal bile duct (below 7 mm in diameter with the gallbladder *in situ*, or less than 9 mm with previous cholecystectomy on transcutaneous ultrasonography), a dilated bile duct (diameter above these limits), or an intraductal image suggesting a stone on transcutaneous ultrasound or computed tomography scan. Pancreatitis was defined as the association of upper abdominal pain with pancreatic enzymes (serum amylase, serum lipase, or both) increased above 4-fold the upper limit of the normal.

Statistical Analysis

The first set of analyses was done on the whole population of 880 patients. Quantitative data were compared with Student *t* tests for the presence of choledocholithiasis (defined by the result of EUS). Then Receiver Operating Characteristics (ROC) curves were used to determine ideal cutoff values for those variables significant on *t* tests.¹⁰⁻¹¹

The whole population was subsequently randomly divided in two subsamples named A and B. These were compared by χ^2 and *t* tests. The comparability was excellent except for the age (mean age in subsample A = 59.2 years vs. 56.2 years in subsample B; *p* = 0.01). Subsample A (*n* = 456) was used for the determination of significant predictors by univariate analysis (χ^2 tests) and logistic regression. Because an interaction appeared between the age and other predictors, the multivariate analysis was performed separately for patients older and younger than 70 years. The

Table 1. FREQUENCY OF CBDS FOR QUANTITATIVE VARIABLES*

		% CBDS	<i>p</i>
Age	<70	13.2	0.001
	>70	33.8	
Bilirubinemia	<4 × N	18.3	0.01
	>4 × N	36.5	
AST	<4 × N	18.5	0.01
	>4 × N	37.2	
ALT	<6 × N	18.3	0.001
	>6 × N	39.0	
GGT	<7 × N	12.9	0.001
	>7 × N	42.0	
Alkaline phosphatase	<2.5 × N	17.5	0.001
	>2.5 × N	44.4	

* χ^2 -test significant after transformation in 2 classes of qualitative variables
ALT = alanine aminotransferase; AST = aspartate aminotransferase; CBDS = common bile duct stones; GGT = gamma-glutamyl transferase; N = normal.

variables included in the model for logistic regression were those significant in the univariate analysis.

In a third step, the expected prevalence of common bile duct stones was calculated for subsample B (*n* = 424) after the number of predictors present, and compared by χ^2_{3df} tests with the observed prevalence of stones in this subsample. Because calculations were done separately for patients older and younger than 70 years, the difference in age between subsamples A and B could be neglected. The test was considered as valid if no significant difference existed between expected and observed percentages of stones in subsample B.

To determine whether the same set of indicators could be used in patient candidates for cholecystectomy, the same analysis was repeated in the subgroup of patients planned for cholecystectomy. Because the "training" sample used for the determination of predictors would have been small with regard to the number of variables to be tested, the analysis was conducted directly on the whole subgroup of 366 patients with planned cholecystectomy.

RESULTS

The overall prevalence of choledocholithiasis among the study population was 18.8% (166 of 880 patients). The prevalence was 14% in patients under 70 years of age, and 32% in patients over 70 years. Six hundred forty-one patients (73.2%) had presented with abdominal pain, 202 (23.1%) with jaundice, 138 (15.8%) with fever, and 79 (9.0%) with pancreatitis; 75 (8.6%) had spontaneously resolving cholangitis. The proportion of patients with strictly normal liver and pancreatic enzymes was 54.7%. The significant quantitative variables for the presence of CBDS were age, bilirubinemia, serum transaminases AST and

Table 2. FREQUENCY OF CBDS FOR QUALITATIVE VARIABLES

	% CBDS	p
Resolving cholangitis		
Yes	16.2	NS
No	20.3	
Jaundice		
Yes	35.5	0.001
No	15.2	
Abdominal pain		
Yes	21.1	NS
No	17.2	
Fever		
Yes	40.8	0.001
No	16.1	
Pancreatitis		
Yes	7.5	0.05
No	21.2	

CBDS = Common bile duct stones.

ALT, GGT, and alkaline phosphatase (Table 1). Pancreatic enzymes were not significantly different between patients with or without choledocholithiasis. Receiver Operating Characteristics curves determined the following ideal cutoff values for biologic criteria: bilirubinemia: 4-fold the normal; AST: 4-fold the normal; ALT: 6-fold the normal; GGT: 7-fold the normal; alkaline phosphatase: 2.5-fold the normal. For the age variable, 70 years was determined as the ideal cutoff value. In subsample A, the qualitative variables that were found to be significantly associated with the presence of ductal stones were the existence of jaundice or fever at presentation ($p < 0.001$ for both criteria), a pancreatitis at presentation ($p < 0.05$) as well as a dilated common bile duct ($p < 0.001$) or a pathologic gallbladder, *i.e.*, dilated, with gallstones or microlithiasis, or with cholecystitis ($p < 0.05$). Pain at presentation, resolving cholangitis, and previous cholecystectomy were not found to be significant (Table 2).

Because an interaction was found between age and other variables in multivariate analysis, multivariate analysis was done separately for patients younger and older than 70 years. The following variables were incorporated in the multivariate analysis: jaundice or fever at presentation, bilirubinemia $>4 \times$ normal, AST $>4 \times$ normal, ALT $>4 \times$ normal, GGT $>7 \times$ normal, alkaline phosphatase $>2.5 \times$ normal, pathological gallbladder (defined above), and dilated common bile duct or ductal stone on ultrasonography. Pancreatitis was not used in the logistic regression because of little statistical significance in univariate analysis and poorer convergence of the model if this variable was included. The independent predictive variables for the presence of choledocholithiasis in patients younger than 70 years were increased GGT ($>7 \times$ normal), a pathological gallbladder, and an abnormal common bile duct (dilated or

Table 3. MULTIVARIATE ANALYSIS

	Odds ratio	O.R. 95% C.I.	p
Patients < 70 yrs (Subsample A)			
GGT $> 7 \times$ N	5.5	2.4–12.9	0.001
Pathologic gallbladder	3.1	1.3–7.6	0.05
Dilated bile duct or stones	5.0	2.1–11.8	0.001
Patients > 70 yrs (Subsample A)			
GGT $> 7 \times$ N	2.9	1.2–7.4	0.05
Fever	6.7	2.4–19.1	0.001
Dilated bile duct/stones	5.5	2.2–13.9	0.001

GGT = gamma-glutamyl transferase.

with an intraluminal hyperechoic image). In patients older than 70 years, independent predictors were increased GGT ($>7 \times$ normal), fever, and a suspect common bile duct. Odds ratios and confidence intervals are displayed in Table 3.

Comparisons between subsamples A and B showed no difference for any of the qualitative variables and for the means of quantitative variables except age (see Methods section). The prevalence of CBDS in subsample A was 20%, *versus* 18% in subsample B (NS). Percentages of CBDS as observed in subsample B are presented in Table 4 along with the expected percentages, depending on the number of predictors present for patients younger and older than 70 years, respectively. Expected percentages were not different from observed percentages for both age groups (observed percentage of stones in patients younger than 70 years: 14.8%; in patients older than 70 years: 30%).

Table 4. COMPARISON OF OBSERVED AND CALCULATED PERCENTAGES OF CBDS FOR SUBSAMPLE B

Predictors Present	Calculated % CBDS	Observed % of CBDS
Age < 70		
0 (n = 81)	2.7	3.7
1 (n = 131)	9.3	12.2
2 (n = 50)	33.5	22.0
3 (n = 15)	70.5	73.0
Age > 70		
0 (n = 29)	9.4	13.8
1 (n = 18)	33.3	13.2
2 (n = 16)	65.1	43.8
3 (n = 7)	91.8	42.9

Calculated vs. observed: $\chi^2 = 3.3$; $p = \text{NS}$.Calculated vs. observed: $\chi^2 = 3.8$; $p = \text{NS}$.

CBDS in subsample A = 20%, in subsample B = 18%.

CBDS = common bile duct stones.

Table 5. RESULTS FOR PATIENTS WITH PLANNED CHOLECYSTECTOMY

Prevalence of choledocholithiasis (CBDS)		
	Age < 70	Age > 70
No. of patients	293	71
No. of CBDS	54	26
% CBDS	18.4	36.6

CBDS predictors for patients < 70 yrs with planned cholecystectomy (after logistic regression analysis)

Predictor	Odds ratio	95% I.C.	p
GGT > 7 × N	7.4	3.3–16.7	0.001
Dilated bile duct	12.2	5.3–28.2	0.001

Observed percentage of CBDS in patients < 70 years planned for cholecystectomy according to predictors

GGT > 7 × N	Dilated bile duct	% CBDS observed
0	0	6%
1	0	27%
0	1	38%
1	1	90%

CBDS = common bile duct stones; N = normal.

In a complementary analysis, the population of patient candidates for cholecystectomy was analyzed separately. Significant and independent predictors of ductal stones as resulting from logistic regression in candidates for cholecystectomy were increased GGT level (>7 × normal) and the suspect common bile duct in patients younger than 70 years, but only increased GGT (>7 × normal) in older patients (Table 5). The percentage of choledocholithiasis ranged from 6% to 90% depending on the number of factors present (Table 5).

DISCUSSION

Rapidly developing medical technologies that prompt new and often costly diagnostic and therapeutic options coexist with an increasingly scarce financial resources from health insurance systems. The optimal allocation of these scarce resources means that costly technologies should be used rationally, when they are likely to improve patient care, rather than indiscriminately. This phenomenon strengthens interest in low-cost noninvasive diagnostic tests for diseases such as choledocholithiasis. Surgeons have long been familiar with clinical and biochemical criteria to predict, to a lesser or greater degree, the presence of common bile duct stones. They generally and wisely consider that it is worth knowing before rather than after the operation, and they know that relying only on intraoperative cholangiography can be disappointing, with 2% to 3% false-negative and about 2% false-positive results.¹² Moreover,

they have to cope with difficult choices among technical options: whether to perform preoperative ERCP, EUS, magnetic resonance cholangiography—or not—and whether to perform laparoscopy with or without intraoperative cholangiography, intraoperative ultrasonography, laparoscopic extraction in case of ductal stones or conversion into laparotomy, or postoperative sphincterotomy. In nonsurgical settings (*i.e.*, patients presenting in emergency departments for biliary or pancreatic-like symptoms), the question is whether to stop the explorations after liver and pancreatic enzymes have been tested and a simple transcutaneous ultrasonography has been done, or to continue with an EUS, ERCP, or magnetic resonance cholangiography.

Numerous efforts to define predictive criteria for common bile duct stones in the past were largely hampered by methodologic pitfalls or sample selection. Some of the best-designed studies included intraoperative factors, such as the cystic duct diameter or the palpation of the common bile duct, which were not relevant to noninvasive prediction of bile duct stones,^{13–15} or led to cumbersome predictive calculations.^{13,16} The significance of some studies was limited by the small numbers of patients included or the restriction of selection to prelaparoscopic cholecystectomy patients.¹⁷ Most other studies were retrospective and therefore also limited in the validity of their conclusions.^{5,18} The only available meta-analysis revealed a very heterogeneous study population and provided a performance assessment for some predictors in univariate analysis. This study also demonstrated the high specificity but poor sensitivity of some factors, and ultimately did not provide any practical guideline for ductal stone prediction.⁵ Deciding on the gold standard diagnostic method which will serve to determine the final diagnosis is always a problem, particularly for common bile duct stones. Indeed, there is no absolute gold standard method, including surgical methods, because of the high propensity of calculi to move spontaneously from the bile duct. However, EUS has been proven to be a highly accurate method, with a positive predictive value of 94.9% to 100% and a specificity of 97% to 100%.^{6–9} In particular, the diagnostic results of EUS can be considered equivalent, or even superior, to those of ERCP and intraoperative bile duct exploration.

Our objective was to define a test that is easy to use, based on almost universally and rapidly available data, and helpful to patient management schedules. Most gallbladder stones are diagnosed by ultrasonography, which also allows measurement of bile duct size. By using this assessment in combination with clinical and biochemical parameters, it should be possible to broadly categorize patients according to the likelihood of duct stones. The relatively large size of our study population allowed for the inclusion of a sufficient number of candidate predictors in a logistic regression analysis, to determine these predictors in a randomly-generated “training” sample and to validate predictors in a complementary “test” sample. The population in this study was not selected, because any patient referred for suspected chole-

docholelithiasis in any clinical setting and from any medical source (*e.g.*, surgeons, general practitioners, intensive care units), was included. The only factor that is probably highly relevant to ductal stone prediction and was not included in the study was the spontaneous variation of biochemical tests. It has been shown that in patients with normalized liver tests, noninvasive imaging allowed high negative predictive values for the presence of ductal stones, and therefore might obviate the need for further invasive testing.¹⁹ However, only one set of biologic tests is generally available when the decision must be made about whether or not to perform invasive investigations. In the subset of 75 patients with spontaneously resolute cholangitis and improving tests, we found that only nine of them (12%) still harbored common bile duct stones at the time of EUS.

Patient age as an essential determinant of an increased risk of choledocholithiasis has previously been identified^{15,17} and shown to interfere with other predictors. Factors such as abdominal pain and hyperamylasemia are poorly predictive of ductal stones.^{5,20} In patients with suggestive symptoms, choledocholithiasis is admittedly unlikely in the absence of biochemical abnormalities in the first few days following the onset of symptoms.^{21,22} In our study, GGT level appeared to be most sensitive, although other factors, such as AST level, were clearly significant. In candidates for cholecystectomy younger than 70 years (older candidates are few and are more likely to undergo ERCP and sphincterotomy straightforwardly), it is not surprisingly that the only factor that was not predictive of ductal stones as compared to the global population was the presence of a pathological gallbladder.

Cotton et al. suggested¹² that patients could be categorized in three groups according to the likelihood of common bile duct stones, as determined by noninvasive tests: very likely, unlikely, and intermediate. Our study fully confirms this assertion: patients with no predictor are unlikely to bear common bile duct stones (2.7–9.4%, depending on age); patients with one or two criteria are intermediate (9.3–66.1%) and patients with three criteria are very likely to bear ductal stones (70.5–91.8%). The figure is even clearer in candidates for cholecystectomy (Table 5).

The question of how to manage these patients has been treated elsewhere^{12,23} and is not the purpose of this study. However, we assume that management strategies could be based upon our predictive test. For instance, we think that invasive or costly diagnostic procedures should not be undertaken if no predictor is present. If the three predictors are present (or both predictors in case of candidates for cholecystectomy), a therapeutic strategy could readily be adopted (either a sphincterotomy followed or not by surgery, or a fully surgical treatment). In intermediate cases in which one or two predictors are present, an accurate but minimally invasive diagnostic method, such as EUS, seems most appropriate: the cost of performing an EUS (including hospital stay, operating room, endoscopist's and anesthetist's fees, consultations, drugs, and laboratory tests) is approximately

\$800 (U.S.), *versus* more than \$2000 (U.S.) for an endoscopic sphincterotomy, which is cheaper than surgical removal of bile duct stones.^{6,9} It has been shown that performing EUS prior to therapy had no significant impact on cost-effectiveness in patients with a high risk of bile duct stones,⁶ but was highly cost-effective in patients with an intermediate risk.⁹

The predictive test requires only commonly available data (clinical, liver enzymes, abdominal ultrasound); its additional cost is therefore nil. In contrast, it may be of great help in defining health policies in a specific field: the number of patients who need endoscopic ultrasonography, ERCP, or intraoperative cholangiography can be estimated; the number of patients with no need for complementary biliary exploration (an unknown percentage of whom would have been explored in the absence of a test) can be predicted; the proportion of patients with unnecessary biliary explorations (false-positives of the test) can be predicted; excess spending on biliary explorations can be determined. Finally, the proportion of patients who need biliary exploration that is not detected by the test (false-negatives) can be predicted (this may result in delaying treatment or postponing treatment while on symptomatic recurrence). If no test is used, invasive or costly biliary exploration procedures are either over- or underutilized, depending upon the local access to these techniques, the practitioner's experience and confidence in the method, and other uncontrollable factors. This may result in management inadequacies and inequalities, as well as inefficient resource allocation.

In conclusion, this study shows that, based on a large and nonselected patient population, a simple screening of patients at risk for choledocholithiasis can be achieved with three predictive criteria according to the patient's age. This test can be adapted to the more specific case of patients undergoing cholecystectomy by using only two predictors (common bile duct size and serum GGT level). Such a test might contribute to reducing unnecessary costly or invasive investigations, and help rationalize the diagnostic strategy for choledocholithiasis.

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